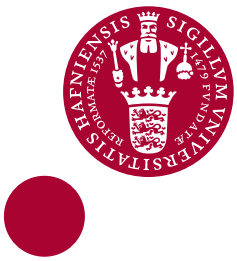

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A Comparison of Ancient Greek and Roman Sports Diets with Modern Day Practices

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Abstract

With the preparations for the Olympics 2016 in Rio came a series of demands to the sports world in terms of attaining optimal physical performance for the many disciplines represented at today's Olympics. In the light of this, we have focused on the dietary and physiological requirements of a modern Olympic athlete and contrast these with those of ancient Greek and Roman athletes. Our particular emphasis has been on the source of nutrients, historical dietary trends, and the search for the optimal sports diet, that is to say a diet that will ensure the attainment of an athlete's full potential. In reality, nothing has changed between the ancient and modern athletes. To be optimal, a sports diet should be nutritionally balanced, whilst accommodating the genetic and environmental requirements, the gender and age needs, the demands of the sports discipline, as well as addressing any cultural dietary restrictions.

Keywords: Sports; Athletic performance; Diet; Dietary fads

Introduction

With the run-up to the 2016 Olympics in Rio, when athletes from all over the World are in training in readiness for forthcoming qualifying heats, we have chosen to take a look at the benefits and disadvantages of ancient versus modern athletic diets, spanning trends and changes that cover some 2000 years of sports-related advice and science.

So many of today's heroes and heroines are sportsmen and women, so it is logical perhaps that a great deal of importance is placed on the improvement of health and physical performance. Indeed, one might even say that this trend has led to the emergence of sports nutrition as an important science. When top athletes meet for a competition, it is a fact that the margin between victory and defeat is often very small [1]. It is for this reason that modern day athletes seek simple, practical and achievable dietary advice to help them reach their physical goals and out-perform their competitors [2]. However, whilst sports nutrition is currently very trendy, it is by no means a new phenomenon.

Limiting factors for exercise performance

Although one might think that the limiting factor for continued exercise would lie with the cardiovascular and respiratory systems, which serve to provide oxygen and remove the by-products of metabolism, it is, in fact, the supply and use of intramuscular and extra-muscular fuel reserves that is critical, ignoring the importance of an elevated core temperature [3-5], which in our context may be considered as a secondary factor. Similarly, we can assume that top athletes know, and have always been aware of, how to prevent dehydration as a limiting factor for performance [6]. The single most consistently observed nutritional factor contributing to fatigue is the depletion of muscle energy stores of the carbohydrate glycogen [7]. Fat and carbohydrate are the principle substrates that fuel the synthesis of energy (via the aerobic ATP production) in skeletal muscle [8]. Anaerobic fuels are derived from the glycogen stores within muscle fibres and systemically from such body depots as the liver, being utilized to form ATP with the resulting production of lactate [9]. An interesting observation is that arms and legs differ in terms of metabolism, such that the muscles of the arms use carbohydrate metabolism even at rest, while leg muscles only switch to 100% carbohydrate metabolism during periods of more intense exercise [10,11]. This may be taken into account when looking at the different athletic disciplines.

Endogenous carbohydrates, mainly stored in muscle and liver as glycogen, represent less than 5% of the total energy stores of an average human being [2,7]. The vast majority of our energy reserves are in the form of stored fat mainly deposited subcutaneously and in depots of adipose tissue around the organs (deep visceral depots). Smaller quantities of fat are present as circulating lipoproteins and in lipid droplets inside the muscle fibres themselves. Protein break-down of muscle tissue for energy is only used as a last resort and in extreme cases and is an unwanted event in athletes, since the buildup of muscles is a long and time-consuming process, requiring high levels of training [2,12]. An interesting suggestion from Blomstrand and Saltin is that the glycogen level per se decides the type of metabolism applied by the exercising muscle [13]. Indeed, there is a higher level of protein breakdown in low glycogen muscles. Professional athletes may also stress their immune system beyond the normal limits associated with healthy exercise, thereby creating an additional need for vitamins and minerals [14].

Ever since muscle glycogen was identified as being the limiting factor for the capacity an individual has to exercise, dietary manipulation to maximize glycogen stores has been a focus of attention. Based on Scandinavian research undertaken during the late 1960´s, modern runners follow a set pattern that involves a reduced level of exercise over a five day period, followed by a day of rest [15].

During this time, three days of a fifty percent carbohydrate diet are followed by three days of a seventy percent carbohydrate diet. This super-compensation in terms of muscle glycogen, also known as "glycogen loading", has been shown to improve the performance of trained runners during races of 30 km or more [2]. This regimen has recently been up for discussion once again, and current thinking favours less carbohydrate loading and more reliance on body fat stores as a source of energy for endurance types of sport [16,17].

The amount of carbohydrate consumed on a daily basis should be related to the extent to which the individual has depleted muscle energy (glycogen) stores in training and competition. Thus, the amount and type of dietary carbohydrate should vary directly with the intensity and duration of the exercise [7].

Diets

Ancient diets

If one examines the paintings on ancient pottery, or looks at ancient sculptures, and if one reads the medical literature from the classical Greek and Roman period, it is apparent that sport was an important part of everyday life, and there is considerable documented evidence of dietary recommendations for ancient athletes by gurus and physicians alike [18-23].

Greeks and Romans consumed a diet which was mainly based on cereal (carbohydrate), olive oil (lipid/fat) and wine [22]. Milk, which could not be kept in a warm climate, was made into cheese, forming a major source of their protein intake [23]. Such a diet would have provided for the fibre and carbohydrate needs, but seems to be somewhat lacking in protein and perhaps also in vitamins. Indeed, reports of medical ailments from the time often refer to eye disorders, "stinking disease" and distended bellies, suggesting that vitamin-deficiency, symptomatic of modern day problems in areas of the world that depend heavily on grain as a staple part of their diet, may have been prevalent [24].

Ancient athletic diets

Not surprisingly, ancient athletes also showed an interest in what pertained to be the most optimal form of nutrition, if they were to maximise their athletic potential. Whilst there are some differences of opinion as to what food-stuff should be preferred by an athlete in training, the general advice in the ancient world was one of a high carbohydrate diet, much in keeping with modern day practices. Early diets for athletes appear to have comprised moist cheese and wheat with such vegetables as peas, beans, onions, radishes, squash, beets and garlic as an important part. The most common fruits were figs, often dried, and grapes along with apples, pears and dates [23].

A lack of animal-derived protein seems to have been rectified early in history, as there are two reports of the introduction of meat into the athletes' diet. One report states that a trainer named Pythagoras recommended a meat diet to the athletes he trained. The second report is that of Pausanias, who writes of Dromeus, a long-distance runner from Stymphalos [23].

"...he won two victories in the dolichos at Olympia, the same number in the Pythian Games, three at the Isthmian and five at the Nemean. He is said to have first thought of eating meat (as part of his training diet). Until then the food for athletes was cheese fresh out of the basket."

Clearly, if his success is anything to go by, then Dromeus had really found a winner's diet. There are also reports of athletes eating meat from oxen, bulls, goats and deer, a very" red-meat" diet which is a rich form of protein. Moreover, with meat as a part of their diet, the performance of competing athletes would most certainly have improved noticeably.

In the early days, athletes relied on their trainer to make sure that their dietary needs were met. However, it was not long before medical doctors took over, and the first sports physicians were created. In a report from Philostratos we learn [23].

"...The Sicilian style of fancy food gained popularity; the guts went out of athletics and, more important, trainers became too easy on their pupils. Doctors took the lead in introducing permissiveness, setting it up as an adjunct to their treatment...from these Doctors athletes learned to be lazy and to exercise after sitting around stuffed with enough food to fill an Egyptian or African meal sack; they gave us chefs and cooks to please our palates. They turned athletes into gluttons with bottomless stomachs."

However, whilst it was popular or fashionable to have a physician designing your diet, it seems that these medical doctors did not always share the same opinion about what the athletes should eat. Celsus, who was not trained as a medical practitioner, although he wrote a great deal about medical practices, and Galen, who was medically trained, did not agree on the type of meat that was the "strongest", that is to say the most nutritious, for an athlete. Celsus preferred beef whilst Galen, who was particularly enthusiastic about the advice given, considering him to be an expert on diet and exercise [25], gave the Olympic gold, so to speak, to pork, which he felt was the most nutritious form of meat. Maybe this was based on his own positive experience with pork when he was a medical practitioner in Pergamon where he took part in the training of gladiators.

Philostratos [23] compared the diet favoured by athletes of"older times" with that of his contemporary athletes. Reported by Nutton [25].

"...Doctors fed us white bread made of ground meal sprinkled with poppy seeds and introduced the eating of fish, contrary to previous medical practice....they also introduced the use of pork with a collection of wonderful theories; they told us that the flesh of herds which had been driven down to the sea should be considered useless because of sea garlic, which the shores and beaches are full of; likewise we should be on guard against pigs raised near rivers, since they may have eaten crabs. The only pork suitable for an athlete´s diet, they told us, was from pigs fed on acorns and cornel berries."

The mention here of poppy seeds and indeed their inclusion in the diet, as an integral part of bread and cakes, is an interesting point for discussion. Poppy seeds contain morphine and consumption of sufficient quantities of poppy seeds can lead to an elevated blood concentration of this particular narcotic [26]. The reason why poppy seeds were sprinkled on bread is not entirely clear, although Galen mentions their use as a form of seasoning which is in accordance with the use of poppy seeds in bread today. However, the fact remains that athletes who were" gluttons with bottomless stomachs" to cite Philostratos [25], and had a taste for fresh bread, may have had appreciable amounts of morphine in their blood and urine. According to the current International Olympic Committee (IOC) Medical Code, morphine is listed as a prohibited substance in class B (Narcotics), with concentrations above one micrograms/ millilitre in urine being reported by IOC accredited laboratories as positive [27]. In reality this

means that a modern day athlete eating two bagels for breakfast would most likely be found to have a positive opiate test of approx. 250 nanograms/millilitre in a urine sample taken some three hours after the bagels had been consumed. This level of a drug from the group of opioids in the urine would not result in disqualification. However, tests have shown that consumption of approximately six grams of poppy seeds can give as much as 1200 nanograms/millilitre of opioids in urine samples taken six hours after consumption, and this would be sufficient to register as a positive test with the IOC accredited laboratories. We have no way of knowing how much morphine was consumed by ancient athletes having a penchant for bread sprinkled with poppy seeds, but it is safe to assume that a considerable amount of bread would have needed to have been consumed before clinical symptoms of morphine in the blood would have been observed. Moreover, we know that ancient physicians were well aware of the effects of poppy seeds and must therefore have used them with some degree of caution [28].

"...Like sesame seeds, the seed of the cultivated poppy is useful sprinkled on bread as seasoning. The whiter seed is better than the darker and has a cooling property, and so is also hypnotic; and if taken in greater quantity it produces lethargy, is difficult to concoct and, further, it inhibits the coughing up of material from the lung and the chest. However, it benefits those suffering from catarrhs from the head, which are accompanied by a thin discharge. But for the body it produces no nutriment worth talking about."

Ancient athletic training programmes and specific diets

In ancient Greece, city-state societies considered athletics as a part of military training [21]. This is reflected in the selection of the primary athletic disciplines, javelin, archery, close combat in armour, chariot racing and last, but not least, running, wrestling and boxing [29]. Training of athletes involved such activities as the carrying of heavy weights, chasing hares and horses, bending and straightening thick rods of wrought iron, yoking athletes to strong horses, or bending back the neck of bulls. Indeed we are told [23].

"...The boxer Tisander from Naxos used to swim around the headlands of his island, and went far out to sea, using his arms, which in exercising the rest of his body also received exercise themselves."

In terms of diets, we also know that specific types of athletes were fed in ways that matched their needs and improved their performance. One such form of sport was the ancient gladiator, and here we learn from Galen, that beans were highly recommended in order to build bulk into such athletes. Galen even goes so far as to state that the bean should be boiled long enough in order to avoid flatulence [28].

On broad beans: "There is also much use made of these, since soups are prepared from them, the fluid one in pots and the thick one in pans. Our gladiators eat a great deal of this food every day, making the condition of their body fleshy – not compact, dense flesh like pork, but flesh that is somehow more flabby. The food is flatulent, even if it has been cooked for a very long time, and however it has been prepared, while ptisane gets rid of all flatulent effect during the period of cooking."

With a balanced diet that included beans, the need for amino acids for protein build-up might very well have been covered, as vegetarian athletes consuming a balanced diet are found to cope equally as well as omnivorous athletes [30,31]. Although being a vegetarian athlete requires a greater degree of awareness with respect to high quality plant protein sources, there is now evidence that frequent, small high quality protein meals are optimal for peak health and performance, preferably ingested as soon after exercise as possible [32]. However, there appears to be no clear difference between slow amino acid releasing and rapidly digested proteins in terms of post training muscle protein synthesis [33].

A diet rich in beans raises another issue, however, since people from the Mediterranean are well-known to suffer from favism, a genetic disease resulting in an acute anaemic crisis after consumption of broad beans in particular [34,35]. This was a known condition in antiquity as the Pythagoric Order stated that one should refrain from eating broad beans [36]. Other athletes, who required rather more stamina than speed, were also fed in a specific fashion. We know that the Olympic Games consisted of a five day programme of events, including ceremonies, chariot- and horse-races, the later requiring sustained use of slow muscles in the arms, legs and back, whilst other disciplines such as the pentathlon, foot-races, wrestling, the pankration (a particularly violent form of wrestling), and boxing, required the training of fast muscles. The latter group of athletes was, according to Galen, treated separately in terms of their diet: [28].

"...Athletes take very wholesome foods, but the heavyweights among them, take foods that are fatty and glutinous. People refer in this way especially to wrestlers, pankration fighters and boxers. Since their whole preparation is with a view to contests in which sometimes they must wrestle, or fight in pankration, all day long, for this reason they also need food which is both difficult to corrupt and not easily dispersed" [28].

Specific diets for modern athletic training programmes

Athletes are typically concerned with dietary manipulations in the period preceding a competition, but it is more likely that the main role of nutrition is to be found in supporting consistent intensive training, which then leads to an improved performance [1].

A good sport-specific conditioning programme is necessary to give an athlete a strong musculoskeletal base on which to build athletic skills, and to decrease the risk of overtraining adaptation. Some individuals are born with a musculoskeletal base which is well suited to wrestling, boxing etc., whilst others are better suited to running, whether this be for a marathon or a sprint race.

The speed with which an athlete can run is determined by his or her genetic capabilities, but also in part by the speed with which he or she can convert chemical energy stores into mechanical energy. These stores may be within the muscle or outside it, and they may or may not require oxygen for their utilisation. The three main forms are short-, medium- and long-term stores. Short-term stores are represented by high energy phosphate bonds as part of creatine phosphate in muscles. These stores are immediately accessible and can be replenished just as quickly, providing for enough energy for a brisk walk of a minute's duration. Medium-stores of energy are those represented by glycogen deposits in the muscle and liver. They provide enough energy for some hours of moderate exercise. Finally, there exist long-term stores in the form of fat tissue, which are typically the fuels needed for success in such disciplines as sprinting, middle-distance and marathon running.

Exercise diminishes energy stores, ultimately causing performance to decline. Long distance runners need to maintain their energy level and use their reserves at a steady and gradual pace. Whilst glycogen stores remain important, new evidence has revealed that high glycemic index food sources do not replenish muscle glycogen stores any better than low glycemic index foods [37]. However, intake of the later will

reduce the risk of excessive energy intake and non-muscle body weight gain. Terminal fatigue, experienced in an endurance event such as the marathon, is often associated with something referred to as" hitting the wall", which is the transition from glycogen to fat as a primary source of energy and an associated decline in running speed. For sprinters, on the other hand, being fast does not necessitate sustained energy levels for very long periods of time. The dietary requirements for these two groups, not surprisingly, vary according to the type of athletic specialization [38].

Endurance athletes

The endurance athlete has a huge need for energy, and it is important that such individuals fill up their glycogen and fat stores in their muscles before performing. Foods rich in complex carbohydrates (e.g. bread, rice, potatoes, pasta) and a great variety of grains, legumes, fruits and vegetables will allow sufficient glucose absorption which can be used to build up and maintain the glycogen stores as to optimise performance [39]. A better understanding of the physiology of muscle, in the light of the fact that muscle glycogen can be optimised, led to the introduction of various forms of dietary manipulation, namely "carbohydrate loading". In its original form, a period of extensive training resulting in the depletion of body glycogen was followed by the introduction of a carbohydrate diet for a period of two to five days. The subsequent "carbohydrate loading" step involved an intensive dietary carbohydrate intake, which usually comprised seventy to eighty-five percent of the total diet, up to 600 g or more, over a period of one or two days [40,41]. Later this form of dietary manipulation was revised to exclude the total depletion of body glycogen stores under exhaustive training, focusing rather on an increase in dietary carbohydrate intake (preferably simple carbohydrates like glucose or fructose) prior to a competition [42].

High-intensity, short duration athletes

Athletes who are involved in high-intensity, short duration sports (of less than twenty minutes) such as track runners, swimmers, sprint cyclists, rowers, wrestlers, weight lifters and gymnasts utilise glycogen as the primary energy fuel [43]. Moreover, it has recently been recognised that diet can affect the performance of high-intensity exercise of short (two to seven minutes) duration [44]. Consumption of a diet high in carbohydrate (seventy percent of total energy intake) for 3-4 days before exercise results in an improved exercise capacity during high-intensity exercise. In accordance with the concept of exercise specificity, the training practices necessary to become a successful wrestler are unique to the sport. It is known that based on age and surface area, the maintenance calorie intake of a wrestler can be determined per day. However, a wrestler should ensure that he consumes a balanced diet if muscle mass and energy requirements are to be maintained. This contrasts with the body weight loss that occurs after an intense five minutes wrestling bout, which is predominately dehydration related [45]. Another sport requiring an intense burst of energy is that of sprinting. This forms a major problem since the enormous demand for energy required if one is to succeed in this discipline has to be supplied by the inefficient process of the so-called anaerobic glycolysis, which is a fast way of getting energy, but a poor way of using the energy stores [38]. Clearly, individuals with a genetic advantage in terms of rapid metabolic control mechanisms with a maximum sensitivity for energy-producing pathways in muscle will be particularly successful as sprinters, if trained appropriately.

A comparison of modern nutritional classes with ancient dietary knowledge

Our modern understanding of nutrition has chosen, with the aid of basic scientific knowledge, to identify six classes of nutrients that the body needs: carbohydrate, protein, fat, vitamins, minerals, and of course water. The ancient Greeks and Romans, however, classified foodstuffs differently when ascribing to them a dual role, that of a nutriment necessary for life and providing the wherewithal for growth and reproduction, and that of a drug or pharmacological agent having a good or bad effect upon the physiological processes of the body. In terms of nourishment, they referred to foodstuffs as having "strong", "medium" and "weak" properties, defined by Celsus [19], thus; [20]

"... It should be known that all pulses, and all bread-stuffs made from grain, form the strongest kind of food (I call strongest that which has most nourishment). To the same class of food belong: all domesticated quadruped animals; all large game such as the wild she-goat, deer, wild boar, wild ass; all large birds, such as goose and peacock and crane; all sea monsters, among which is the whale and such like; also honey and cheese. Hence it is not wonderful that pastry made from grain, lard, honey and cheese is very strong food"

"Among food materials of the middle class ought to be reckoned: of pot-herbs, those of which the roots or bulbs are eaten; of quadrupeds, the hare; birds of all kinds from the smallest up to the flamingo; likewise all fish which do not bear salting or are salted whole"

"The weakest of food materials are: all vegetable stalks and whatever forms on a stalk, such as the gourd and cucumber and caper, all orchard fruits, olives, snails, and likewise shellfish"

Galen defined the process of nutrition as" the assimilation of that which nourishes to that which is being nourished" – in other words, the process by which a substance in the external environment becomes part of an identical substance in a human or animal body [18,22]. The second process required a detailed understanding of what a food (as drug) did to the body, and it was here that the skill of an ancient physician came into play. Galen defined four drug effects or pharmaka, namely: 1) foods that remain unaltered but overcome the body – e.g. deleterious and destructive – poisons, 2) foods that are changed by the body, becoming putrefied and corrupted in the body, and hence also acting as poisons, 3) foods that warm the body but do it no harm, and 4) foods that eventually become assimilated and are both drug and food.

Since our modern understanding and classification of nutrients and nutrition no longer matches those held by Celsus [19] and Galen, and as one cannot be entirely sure that ancient foodstuffs have remained totally unchanged in terms of their nutritional value through to the present day, it is difficult to directly compare the diets of ancient athletes with those used routinely today. However, in the following section an attempt will be made to compare modern and ancient knowledge regarding the benefits of basic nutritional sources for athletes.

Protein

Today most athletes ingest sufficient protein in their habitual diet so that additional protein confers a minimal additional advantage in terms of exercise performance [46]. There are, however, certain sports that require considerations with regard to protein intake and the maintenance of a lean body mass, depending on season and the competition program, an example of which is given by Shaw and

colleagues [47]. Moreover, a series of recommendations are described by Maughan and Burke [48] as well as Burke and colleagues [49]. In fact, there is little to suggest that ingestion of a high amount of protein (two to three grams per kilogram Body Weight per day) is necessary [50]. Rather it seems that the timing of ingestion in relation to exercise and the composition of the ingested amino acids for protein maintenance is more relevant as it aids in the repair and build-up of muscle tissue [51]. If protein is given later with regard to the 'anabolic window', it does not seem to have a major effect. On the other hand, research suggests that in selected disciplines, athletes require a higher protein intake e.g. weight lifters as opposed to gymnasts. Whilst the exact requirements remain un-established, they have for some time been generally accepted as being between seventeen and seventy-four percent above an individual´s Recommended Daily Allowance (RDA) [52], whilst more recent research suggests that the issue of protein quality should also be taken into account, whilst the general consensus is that especially endurance athletes have a higher protein requirement than most other athletes [32]. One explanation for this may lie with the fact that more muscle fibres become damaged as a result of these extreme sports, and as a consequence a greater degree of muscle build-up is necessary [51].

Ancient athletes would most likely not have been able to afford very much protein in the form of meat, and would as a consequence not have eaten meat on a daily basis. However, we know from Celsus [19] and Galen [22] that meat in the form of terrestrial and aquatic livestock was considered nutritious, and was classified among the "strong" foodstuffs. Celsus and Galen [19,22] could not, however, agree as to which meat was the "strongest", Celsus [19] favoured beef, whilst Galen [22] never misses a chance to sing the praises of pork, which alongside fresh milk was his favourite food.

"Among food from domesticated quadrupeds pork is the weakest, beef the strongest. And so also of game, the larger the animal the stronger the food yields" [19].

"Flesh, when well concocted, produces the best blood, especially in the case of animals such as the pig family, which produce healthy humour. Pork is the most nutritious of all foods, and athletes provide a very visible test of this. For when, after identical exercises, they take the same amount of a different food on one day, straightway on the following day they appear not only weaker but also obviously less well fed."

"Beef itself gives a nutriment that is neither small in quantity nor easily dispersed; yet it produces blood that is inappropriately thick" [28].

"*Lambs also have flesh that is very moist and productive of mucus. But that of adult sheep is more productive of residues and more unwholesome. The flesh of goats is unwholesome too, with bitterness" [28].*

Poultry was also considered a nutritious foodstuff, although here size mattered. Celsus [19] ascribed poultry to the "medium" class of foodstuffs, whilst Galen was not so generous in his appraisal, preferring once again to extol the virtues of pigs and terming poultry meat as "*poorly nutritious*".

"Likewise of those birds, which belong to the middle class, those which rely more on their feet are stronger food than those which rely more on their wings; and of those birds which depend on flight, the larger birds yield stronger food than the smaller, such as fig-eater and thrush. And those also which pass their time in the water yield a weaker food than those which have no knowledge of swimming" [19].

"The family of all winged animals is poorly nutritious when compared with that of terrestrial animals, especially pigs: you would find no flesh more nutritious than theirs" [28].

Fish too were classified as a "middle" foodstuff by Celsus [19], although here preference was given to the oily fish such as mackerel in comparison with bass and mullet. This is in accordance to general recommendations today concerning intake of oily fish like salmon and tuna, although the reason given here is to prevent heart diseases. Galen goes one step further in his assessment of fish, telling us that they are not appropriate for athletes but should rather be reserved for those who are weak and ill.

"The fish most in use belong to the middle class; the strongest are, however, those from which salted preparations can be made, such as the mackerel; next come those which, although more tender, are nevertheless firm, such as the gilthead, gurnard, sea bream, eye fish, then the flat fish, and after these still softer, the bass and mullets, and after these all rock fish" [19].

"But from all the above fish the nutriment is best for those who are not in training, and the idle, frail and convalescent. People in training need more nutritious food, about which there has been previous comment" [28].

Ancient athletes would also have obtained protein from two other sources, namely milk and associated products, and beans. Galen [22] was particularly clear about his thoughts on the nutritive value of fresh milk, but he also pointed out to his readers that prolonged use of milk could have adverse effects on dental health. Regarding beans, Celsus [19] ranks them higher than peas in terms of nutritive value, but Galen [22] interestingly, associates them with what he terms "spongy flesh", something one would not wish to develop in an athlete.

"...the best milk is just about the most wholesome of any of the foods we consume"[28].

"For cows´ milk is very thick and fatty, while milk from the camel is very liquid and much less fatty; and next to the latter animal is that from mares, and following this, ass´s milk. Goat´s milk is well proportioned in its composition, but ewe´s milk is thicker" [28].

"Its continued use also harms the teeth, together with the flesh surrounding them, which they call "gums". For it makes these flabby, and makes the teeth liable to decay and easily eaten away. Accordingly one should rinse the mouth with diluted wine after consuming milk, and it is better if you put honey with it" [28].

"Moreover it is neither unwholesome nor very markedly productive of thick humour, a common charge against all cheeses. A very fine cheese is the one highly regarded by the wealthy in Rome (its name is bathysikos), as well as some others in other regions" [28].

"Among pulses, beans and lentils are stronger food than peas" [19].

"However, they [Figs] do not produce firm, strong flesh like bread and pork do, but a spongy flesh, as the broad bean does" [28].

Carbohydrate

Carbohydrate in the form of glycogen is the body´s main fuel for activity of a high intensity. Carbohydrate is stored as long chains of glucose units (glycogen) in the liver and in muscles, where in the latter levels are relatively small and rapidly reduced during training and

competition [53]. It is recommended that modern athletes should ingest between three to twelve grams per kilogram body weight per day of carbohydrate to restore and maintain muscle glycogen levels, depending on the type of sport performed [54]. Athletes involved in team sports rely greatly on glycogen stores, thus maximising muscle glycogen stores prior to performance results in greater endurance and delayed fatigue. Likewise, athletes such as wrestlers and sprinters should ingest high carbohydrate diets during intense periods of training as this will enable higher intensity training [55].

The principle carbohydrate source available to the ancient athlete was grain, usually prepared as bread. Celsus [19], who classified bread as a "strong" food, could not sing the praises of any other foodstuff higher than that of bread, and even went so far as to rank the different bread types in terms of their nutritional benefit. Galen [22], true to character, is more specific and mentions which types of bread are suitable for those in training.

"Whilst there is more nutriment in bread than in anything else, wheat is a stronger food than millet, and that again than barley; and of wheat the strongest is siligo, next simila, then the meal from which nothing is extracted, which the Greeks call autopuros; weaker is bread made from pollen, weakest the common grey bread" [19].

"So among breads too, while one that has not been very well baked nor has much leaven is suitable for an athlete, and one that has been very well baked in the oven and has much leaven is suitable for an ordinary individual or an old person, one which is absolutely unleavened is not fit for anybody" [28].

Complex carbohydrates in the form of legumes and vegetables would also have formed a considerable part of the ancient athletes' diet. Whilst Celsus [19] provides us with a clear rank order for their nutritive value, Galen [22] seems unimpressed with vegetables as a whole, stating that they give "little nutriment to the body" and that they are "*all unwholesome*".

"Of vegetables the turnip and navew and all bulbs, among which I include the onion also and garlic, are stronger than the parsnip, or that which is specially called a root. Also cabbage and beet and leek are stronger than lettuce or gourd or asparagus" [19].

"Not only do we eat the seeds and fruits of plants, but also the plants themselves, often whole, but often only the roots, branches or young shoots, according as there is a pressing need for each. It is clear that, as well as giving little nutriment to the body, these are all unwholesome except, as I said, the spiny plants that have just emerged from the ground"[28].

The later comment about spiny plants that have just emerged from the ground suggests that Galen [22] was aware of the importance of what we now know to be micro-nutrients, although he would have been totally unaware of the existence of such compounds, just of their apparent effect, perhaps through studies involving their absence from a balanced diet. This in turn raises the aspect of micro-nutrients, and the connection between a well-balanced diet and the immune system, which has been shown to be of considerable importance in terms of athletic performance [56].

The work and general hypothesis of Nieman indicates that intense or prolonged exercise and over-training depresses the immune system, whilst moderate exercise enhances immune function [57]. In support of this, Pastva et al. [58] have elegantly demonstrated that exercise on a regular basis has a beneficial anti-inflammatory effect mediated via an exercise-induced increase in glucocorticoids (naturally present in the body as hormones, but also drugs known to have an anti-inflammatory effect) [59]. Additionally, a diet rich in vital nutrients, especially anti-oxidants such as vitamin C and vitamin E, provides support for the immune system of athletes who are following a heavy training programme.

Finally, as stated by Clyde Williams [55], it is, however, important to remember that a high carbohydrate diet increases the capacity for exercise, rather than the rate of performing exercise [60].

Fat

Although there is interest in the recovery of intramuscular fat stores consisting of triglyceride between training sessions, and it is well known that fats are essential for membrane function and cellular health, as well as the protection of body organs, there is no evidence that diets, which are high in fat per se and restricted in carbohydrate, enhance training [2]. Indeed, it is well known that added fat and fibre increases dietary bulk, slows gastric emptying, increases the filling of the intestines, and thereby interferes with a training schedule. However, a short-term (five to six days) ingestion of a high-fat diet (more than sixty percent of calories from fat) followed by a one day carbohydrate load seems to be of benefit for athletes of the ultra-endurance activities [61].

Concerns about specific fat intake were never mentioned for the ancient athletes.

Vitamins and minerals

Today there is a lot of discussion and emphasis placed on such micro-nutrients as vitamins and minerals, and they form an important part of modern diets for athletes. Likewise, in a Mediterranean diet, one would normally expect individuals to be exposed to a high vitamin diet with plenty of fruit and vegetables, as well as sufficient sunshine to provide vitamin D. Celsus [19] favoured grapes and figs in preference to the softer and more fleshy fruits, whilst Galen was rather scathing in his assessment of fruits in general, terming them "*poorly nutritive*".

"But of fruit growing on twigs, grapes, figs, nuts, dates are stronger than orchard fruit properly so-called; and of these last, the juicy are stronger than the mealy" [19].

"Generally speaking...regarding fruits edible for man, that the nutriment the moist ones produce and deliver to the body is moist and thin. This is why all such foods have been properly described by physicians as poorly nutritive" [28].

Galen [22] was, however, largely against the consumption of fruit of all kinds because he had himself been ill for a long while after eating a little fresh fruit and, additionally, since fruit was always liable to rot in a hot Mediterranean climate, especially apricots, peaches and nectarines [26]. However, Galen [22] did recognise that figs, whilst having little nutritional value, are beneficial to the basic physiological process of passage of foodstuffs through the body.

"Figs possess the feature that is common not only to all late-summer fruits, but to those called "seasonal", since not even they can avoid producing unhealthy humour. But there are benefits associated with them, both the fact that they have a rapid passage through the stomach, and that they move easily through the body as a whole. And while all the late-summer fruits give little nutriment to the body, this is least of all so with figs" [28].

Fluid

Finally, we should address the issue of fluid intake. The ancients had serious problems with clean water and so little of this was inbibed. Instead, besides fresh milk, the virtues of which have already been "sung" by Galen [18], most people would have drunk some form of wine or alcohol-rich drink, and here we note the observation of Celsus [19].

"Of drinks too the strongest class are: whatever can be made from grain, likewise milk, mead, must boiled down, raisin wine, wine either sweet or heady or still fermenting or of great age" [19].

In terms of exercise, it is well known that particularly intense training bouts undertaken in a warm environment will result in dehydration. Furthermore, the effects of dehydration can subsequently impair thermoregulation, cardiovascular and metabolic processes, which will all have a knock-on effect in terms of exercise performance. Recent studies have shown that water replacement alone can be a significant benefit to the prolongation of exercise [4]. Indeed the recommendations made by the SDA are that "to maintain an optimal hydration status, fluids that are cool and appropriate (e.g. water and milk) be supplied in sufficient quantities to adolescent athletes before, during and after participation in sport" [61], recommendations that can obviously be applied to adult athletes too. However, hyper-hydration has not been shown to give an advantage over a eu-hydrated state with regard to thermoregulation during exercise [62,63].

Ancient athletes and dietary/health issues

By eating a variety of foods, athletes can ensure that they obtain the forty or more different nutrients they need to help their body function properly. A professional athlete must ensure an optimal nutrient and energy status to support development and growth of body tissues, optimise metabolism and maintain a healthy immune function. Physical activity often results in tissue damage, with an adequate dietary intake providing the necessary building constituents needed for tissues to recover fully. Galen would have been aware of this as the doctor for a large group of different types of athletes and gladiators.

It is most likely that cooking was performed centrally for all, and it was therefore important to make sure that the food, that was provided, was universally tolerable [23]. As the group consisted of males who came from the Mediterranean area, there is as mentioned some risk that a percentage of the athletes would have suffered from a genetically based enzyme defect - glucose-6-phosphate dehydrogenase deficiency, also called favism, causing haemolytic by intake or contact - as indeed is still the case in these areas today [34-36,64,65]. A diet mainly based on beans would therefore not seem to be an obvious option when wishing to provide ancient athletes with a high protein diet in the Mediterranean region.

Modern versus ancient athletic diets: concluding remarks

The search for an optimal diet for athletes today, compared with competitors in ancient Greece, has not changed fundamentally. Indeed, the drive to improve one's physical performance through slight, yet vital, changes in diet prior to and during exercise training is just as hot a topic as it ever was.

Present day dieticians, as well as physical exercise physiologists, have been trying to improve an athlete´s performance through the use of so called "ergogenic aids", among which are amino acid supplements, carbohydrates, and a range of mineral salts [66]. However, the scientific basis for the use of vitamin supplements and antioxidants before and during performance remains uncertain, and studies aimed at assessing the degree to which different training levels induce oxidative stress in muscles remain inconclusive. A prudent recommendation for athletes is therefore to ingest a diet rich in antioxidants rather than taking supplements [67].

A typical triathlete diet is shown below, taken from the homepage of Jesse Thomas. This choice is deliberate because we wish to illustrate what sort of food stuffs and drinks are selected by a top modern athlete, who is not participating in a research study:

Breakfast: Two peanut butter and jelly rice cakes, bowl of cereal, two eggs, First Endurance MultiVitamin and Optygen HP (micronutrient supplement).

Workout: First Endurance EFS and/or Liquid Shot, if low intensity, supplement with Picky Bar(s), aim for 200–400 calories per hour, lots of water.

Recovery: First Endurance Ultragen (high protein, carbohydrate drink with essential macro and micro-nutrients), banana or Picky Bar.

Lunch: Chicken sandwich, goat cheese and guacamole, Pop Chips with more guacamole, apple

Snack: Picky Bar or peanut butter and jelly rice cakes or both.

Workout and Recovery: Same as above.

Dinner: Pad Thai or sushi or gluten-free pizza or hamburger and fries, etc., salad or some cooked veggies.

Dessert: Two peanut butter and jelly rice cakes, bowl of frozen berries, usually another bowl of cereal.

A thorough description of eating patterns in modern elite athletes, describes that snacks, defined as food and drink consumed between meals, typically provide twenty-three percent of the daily energy intake and are often chosen from sources high in carbohydrate and low in fat and protein [68]. The real-life example above confirms this trend.

Whilst the modern diet for a high performance athlete looks like something you would expect a glutton to eat, it makes perfect sense in terms of an athlete's need to replenish energy reserves after training and competition and to repair damaged body tissue. Perhaps more surprisingly, however, it seems that this view regarding excessive diets fed to athletes is not a new one taken in the light of comments by Galen and Philostratos [22].

"...Athletes take very wholesome foods, but the heavyweights among them, take foods that are fatty and glutinous" [28].

"From these Doctors athletes learned to be lazy and to exercise after sitting around stuffed with enough food to fill an Egyptian or African meal sack; they gave us chefs and cooks to please our palates. They turned athletes into gluttons with bottomless stomachs" [23].

In the light of the accumulated written evidence regarding foodstuffs and their use in connection with ancient athletes, one cannot help but wonder whether the ancient trainers and physicians actually had a far better understanding of the dietary needs of their wards than we may care to give them credit for. Indeed, whilst it is impossible to prove, the comments by Philostratos [23] regarding the glutinous activity of ancient athletes in the care of physicians might be interpreted as a clear move away from the participation of sports amateurs to that of more professional athletes fed and trained to ensure success in Olympic events.

A few major differences do exist today, however, compared with ancient athletic games, the main being participation of women and the many different nations. Apart from gender differences in energy needs, another fundamental difference between then and now is the global dietary tolerance, governed by genetic differences, as well as cultural influence, that now plays an added role in a modern athletes' performance. Thus, whilst general principles in terms of arriving at an optimal athletic diet still hold true, the application of these principles in a modern population of athletes is far more complex due to a lack of environmental, genetic and dietary homogeneity. Now, more than ever, athletes have a specific and individual need for dietary advice when competing at a National and International level.

Perspective

From ancient times, sport in its most competitive form, namely the Olympic Games, has been regarded and practiced as a kind of art embodying the concept of perfect health with that of perfect performance. Clearly, the concept of perfect health should be related to an individual's genetic characteristics and environment, but it also has a lot to do with adequate training and nutrition. The Ancients were prone to fads and conflicting opinions concerning their training and dietary needs, as is still the case today. Ancient athletes started out with a low protein and high vegetable diet, but as we have seen, this quickly changed to a more meat-based diet as recommended by personal trainers and physicians. Whilst one would tend to think that by eating meat one should be best able to serve ones muscle performance needs, work done in the early 1900´s showed that for athletes asked to perform out-stretched arm and deep knee bends, those fed a vegetarian diet performed no worse than their meat-eating counterparts [69]. Thus if the work of Fisher, and more recent studies [30,70], is to be believed, then perhaps the Ancient athletes were at no disadvantage after all, and the advice they received subsequently from self-styled authority figures may not have offered any significant benefit. Interestingly, modern diets consumed by triathletes, the majority of whom are not vegetarians, closely resemble those consumed by the very early ancient athletes, namely such food products as cheese, cereals, vegetables and fruit. Hence, athletic performance is more closely associated with the consumption of a balanced diet, addressing an individual's carbohydrate, protein, fat and micro-nutrient needs, than it is related to particular fads and trends, which appear to have plagued the sports world over the millenia.

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